Outbreak, Surveillance, Investigation & Response (OSIR) Journal

Field Epidemiology Training Program, Division of Epidemiology
Department of Disease Control, Ministry of Public Health, Thailand
Tel: +6625903894, Fax: +6625903845, Email: osireditor@osirjournal.net, http://www.osirjournal.net

# An Intermittent Gastroenteritis Outbreak of Rotavirus Genotype G9P[8] in a Hotel in Songkhla Province, Thailand, April–May 2019

Choopong Sangsawang*, Sawanya Chantutanon, Laddawan Sukhum, Thidapon Thepparat

Office of Disease Prevention and Control Region 12 Songkhla, Department of Disease Control, Ministry of Public Health, Thailand

*Corresponding author email: sangsawangchoopong@gmail.com

**Abstract**

A series of acute gastroenteritis outbreaks occurred among participants of two seminars at a hotel in Songkhla Province during 26–29 Apr 2019 and 8–10 May 2019. Investigations were done to determine the causes of the outbreaks and recommend control measures. A case was defined as a participant who developed diarrhea, vomiting, nausea or abdominal pain between 26–30 April (Seminar 1) or 8–13 May (Seminar 2). Samples of the drinking and cooking water used during the seminars were taken and rectal swabs from cases and food handlers were collected for bacterial culture and viral reverse transcription polymerase chain reaction tests. A retrospective cohort study was conducted to identify risk factors. Of 349 participants interviewed, 237 were cases, giving an attack rate of 67.9%. The ages of the cases ranged from 11–57 years (median 15 years). The most common symptoms were watery diarrhea (94.1%), abdominal pain (81.0%) and nausea (57.8%). Rotavirus was detected in five cases, three food handlers and a sample of water used for cooking. All were of the same genotype G9P[8]. Implicated dishes included spicy seafood salad (adjusted odds ratio (AOR) 4.5, 95% confidence interval (CI) 1.7–11.8), shrimp in sauce (AOR 2.9, 95% CI 1.0-8.2), roast duck with vegetables (AOR 2.9, 95% CI 1.2–7.3) and water from a cooler (AOR 2.0, 95% CI 1.0–3.9). Contaminated water and infected food handlers were probable sources of cross-contamination. After the hotel's water system was repaired and the food handlers were educated on safe food handling practices and good personal hygiene, no other outbreaks associated with the hotel were reported.

**Keywords:** rotavirus, food poisoning outbreak, Songkhla

## Introduction

Group A rotaviruses (RVA) are the most important cause of acute gastroenteritis in humans globally, especially among young children in developing countries.[1,2] Five genotypes (G1P[8], G2P[4], G3P[8], G4P[8], and G9P[8] represent over 90% of global human RVA.[3] A previous study showed that G9P[8] strains emerged and predominated in Ghana in the 4th quarter of 1999 and caused a severe rotavirus outbreak among children in Central Australia during 2001.[4,5] Rotavirus infection among adults has been associated with a wide spectrum of disease severity and manifestations. The illness most frequently begins 2–6 days after ingestion of the pathogen and continues for 1–4 days, with common symptoms including diarrhea, fever, headache, malaise, nausea, and cramping.[6] Clusters of rotavirus infections in adults most frequently occur in communities, and one of the largest outbreaks involved nearly 3,500 people in 1964 in an isolated area of Micronesi.[3,7] Outbreaks of rotavirus infection have also occurred in long-term healthcare facilities, particularly those with close living quarters; thus, compromised host immunity and multiple comorbid disorders might help facilitate the spread of infection.[8–13] The primary mode of transmission is the fecal-oral route usually through direct contact between people. However, since the virus is stable in the environment, transmission can also occur through ingestion of contaminated water or foods and contact with contaminated surfaces or objects.[14] The other most common causative agents of viral gastroenteritis in humans worldwide are noroviruses, adenoviruses, and astroviruses, most of which are transmitted via the fecal-oral route, including contaminated food and water and presenting symptoms include watery diarrhea, nausea, vomiting, fever, and abdominal pain.[15] Norovirus is a single stranded RNA virus belonging to the family *Caliciviridae.* The virus is transmitted by low doses and common symptoms include vomiting and diarrhea. Infections are more common in winter. Human adenoviruses are double strand viruses belonging to the family *Adenoviridae*. Serotypes 40 and 41 are the most remarkable pathogens associated with acute gastroenteritis. Human astroviruses are single-stranded RNA viruses belonging to the *Astroviridae* family. Diarrhea is common but milder than those caused by rotaviruses or noroviruses, and symptoms resolve spontaneously.[16–18]

A series of acute gastroenteritis outbreaks occurred among participants of two seminars held at a hotel in Songkhla Province on 26–29 April and 8–10 May 2019. On 29 April, the Office of Disease Prevention and Control was notified of the first cluster of acute gastroenteritis cases among participants of the first seminar. The first participant became ill with acute watery diarrhea, abdominal pain, nausea, and vomiting on 27 April. Most of the cases were adults who came from other provinces and planned to go home on that day. A joint investigation was initiated promptly on 29 April. A bacterial cause was suspected so rectal swabs were obtained from participants and sent for bacterial culture. All swabs were negative for a bacterial pathogen.

On 7–8 May, a second laboratory investigation was done to detect a possible viral pathogen. Rectal swabs from food handlers and water samples were collected and tested. During the process of investigation on 12 May, there was a notification of a second cluster of gastroenteritis cases among participants of a second seminar at the hotel with the same clinical presentation as the cases who attended the first seminar. Hence, a joint investigation was conducted during 29 Apr to 13 May 2019 to identify the causative agent, source of illness and recommend control and prevention measures.

## Methods

A list of seminar participants was obtained from registration records. Face-to-face and telephone interviews with the participants of the two seminars were conducted. Respondents were interviewed about their demographics, clinical signs and symptoms, and food and water consumption while attending the seminars. A probable case was defined as a participant who had at least one of the following symptoms: diarrhea, vomiting, nausea, or abdominal pain and with an onset date between 26–30 April among participants of the first seminar or 8–13 May among participants of the second seminar. A confirmed case was defined as a probable case with a positive test result for rotavirus or norovirus by reverse transcription polymerase chain reaction (RT-PCR).

Separate retrospective cohort studies were conducted among participants of each seminar. All available participants were interviewed to classify their exposure to various food and drink during attending the seminars. The various food and drink consumed during 26–27 April for the first seminar and 8–9 May for the second seminar were included in the analysis. Those who met the probable case definition were designated as cases. A non-case was a participant who had no sign nor symptom during the same time period. Relative risk was used to demonstrate an association between eating a particular food or drink at the hotel and the risk of being ill.

Rectal swabs were obtained from 25 symptomatic cases who had a date of onset not more than 8 (first seminar) or 3 (second seminar) days before the collection. Rectal swabs were also obtained from all asymptomatic food handlers employed by the hotel during the seminar. Cary Blair transport media and universal transport media were used for bacterial and viral testing, respectively. Bacterial cultures were tested at Songkhla Hospital, Hatyai Hospital and Bamrasnaradura Infectious Diseases Institute. RT-PCR tests for rotavirus, adenovirus, astrovirus and norovirus were done at Bamrasnaradura Infectious Diseases Institute. Samples of cooking and drinking water and ice were collected for bacterial culture at the Regional Medical Science Center 12 Songkhla and viral RT-PCR for rotavirus, norovirus, adenovirus, astrovirus and sapovirus at the Neuroscience Centre for Research and Development. Positive specimens of rotavirus among humans were tested for genotypes by the conventional RT-PCR method at Neuroscience Centre for Research and Development.

We inspected the food and water sanitation facilities of the hotel. Food handlers who worked at the kitchen and the restaurant during the seminars were interviewed.

Descriptive statistics were presented by computing percentages, medians and ranges. The Chi-square test was used to compare the proportion of risk factors between exposed and non-exposed groups. Multiple logistic regression models were used for multivariate analysis. Variables with a $p$-value less than 0.2 from univariate analysis were included in the multivariate model. Adjusted odds ratios (AOR) and 95% confidence intervals (CI) were calculated. All probabilities were 2-tailed, and $p$-values $<0.05$ were considered significant. All analyses were conducted in Stata version 14.

## Results

### Epidemiologic Investigation

The affected hotel, located near Samila Beach in Songkhla Province, consists of 208 bedrooms. The first seminar included participants from the Nationwide Youth Network and was held during 26–29 Apr 2019. The second seminar contained students from the Science Match Ability program of a high school and was held during 8–10 May 2019. There were 447 participants of both seminars, of which 349 (78.1%) were interviewed. The attack rate was 67.9% (237/349). There were five confirmed rotavirus cases and two confirmed norovirus cases. The age of the cases ranged from 11–57 years (median 15 years) and 120 (50.6%) were female. Three (1.3%) were hospitalized and there were no deaths.

The first seminar consisted of 208 participants, of which 144 were interviewed and 96 were probable cases with no confirmed case giving an attack rate of 66.7%. One case was hospitalized. The ages of the cases ranged from 12 to 46 years (median 19 years). The sex-specific attack rates were 66.3% (57/86) among male and 67.2% (39/58) among female participants. Most (95%) cases were Thai nationals from 40 provinces and 5 (5.2%) were foreigners from India and Sri Lanka. Symptoms of illness were watery diarrhea (91.7%), abdominal pain (76.0%), nausea (56.3%), vomiting (42.7%), fever (39.6%) and mucous diarrhea (4.2%) (Figure 1). The first case developed symptoms on 27 April at 7 p.m. and as shown in Figure 2, the peak occurred on 28 April. The suspected meal was the welcome dinner on 26 April 2019, at 6 p.m. The median incubation period was 2 days (range 1–3 days).

The second seminar contained 239 participants and included teachers and students. Of 205 (85.8%) interviewees, 141 cases were identified (attack rate 68.7%) and 2 (1.4%) cases were hospitalized. The sex-specific attack rates were 67.4% (60/89) and 69.8% (81/116) among male and female participants, respectively. The ages of the cases ranged from 11 to 57 years (median 15 years). The attack rate among teachers and students was 53.3% (8/15) and 70.0% (133/190), respectively. Symptoms of illness were watery diarrhea (95.7%), abdominal pain (84.4%), nausea (58.9%), fever (55.3%), vomiting (37.6%) and mucous diarrhea (2.1%) (Figure 1). The first case developed symptoms on 8 May at 3 p.m. and as shown in Figure 2, the number of cases peaked on 10 May. The median incubation period from the first meal was 2 days (range 1–4 days).

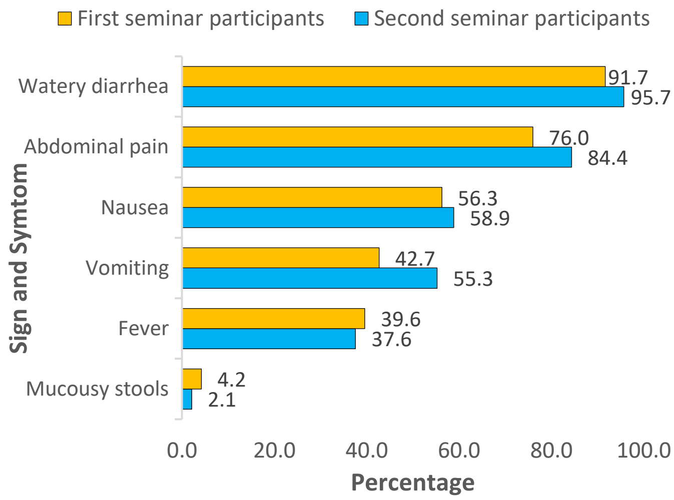


**Figure 1. Signs and symptoms of acute gastroenteritis cases among the first seminar participants (n=96) and the second seminar participants (n=141), Songkhla Province, 26 Apr–13 May 2019**

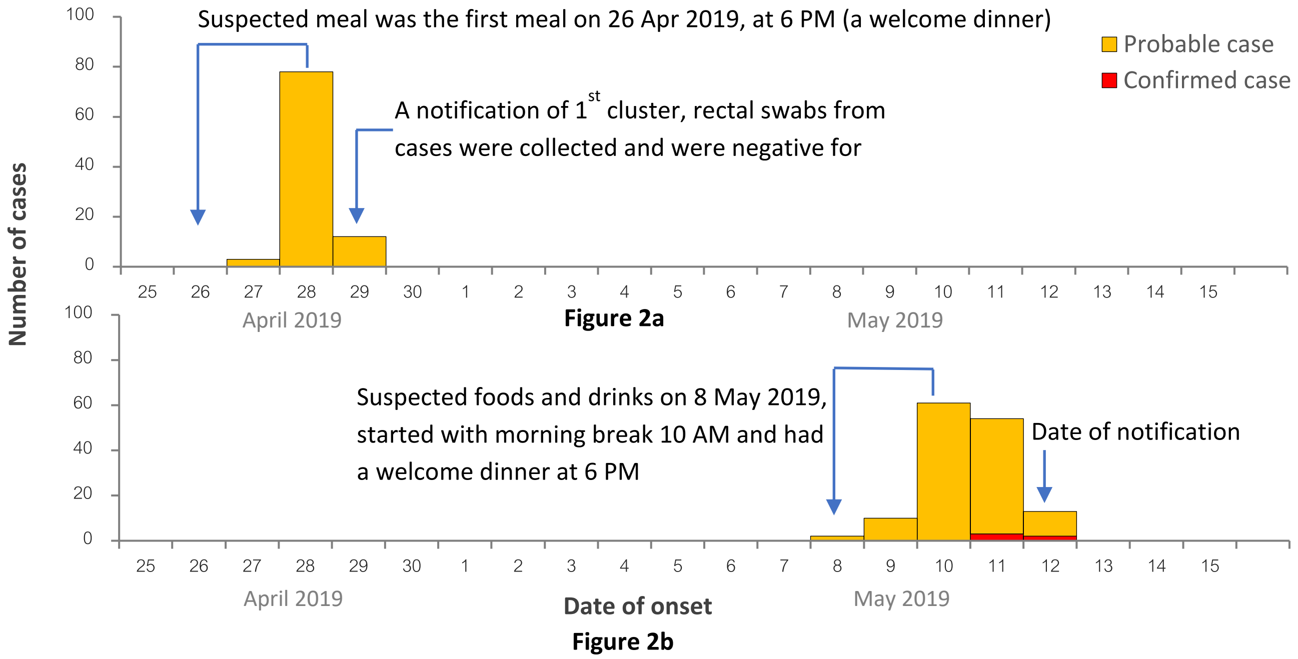


**Figure 2. Number of gastroenteritis cases by date of onset among the first (Figure 2a, n=96) and second (Figure 2b, n=141) seminar participants, Songkhla Province, 26 Apr–13 May 2019**

**Retrospective Cohort Studies**

A total of 144 interviewees from the first seminar and 205 interviewees from the second seminar were included in the analysis. Univariate analysis showed many food items were significantly associated with being a case for both seminars (Tables 1 and 2). On multivariate analysis, food items with an elevated risk for disease in the first seminar were the spicy seafood salad (AOR 4.5, 95% CI 1.7–11.8), shrimp in sauce (AOR 2.9, 95% CI 1.2–8.2), and roast duck with vegetables (AOR 2.9, 95% CI 1.2–7.3). In the second seminar, drinking water was the only significant risk factor (AOR 2.0, 95% CI 1.03–3.9).

**Table 1. Risk factors in a gastroenteritis outbreak among the first seminar participants, Songkhla Province, 26–29 Apr 2019 (n=144)**

| Food items (date and time served) | Exposed | | Non-exposed | | Crude RR (95% CI) | Adjusted OR (95% CI) |
|---|---|---|---|---|---|---|
| | Case | Non-case | Case | Non-case | | |
| **26 April, 6 PM** | | | | | | |
| Spicy seafood salad | 73 | 18 | 17 | 30 | 2.25 (1.52–3.33)[b] | 4.51 (1.71–11.84)[b] |
| Shrimp in sauce | 77 | 24 | 16 | 24 | 1.92 (1.29–2.85)[b] | 2.91 (1.03–8.17)[b] |
| Roast duck with vegetables | 62 | 18 | 30 | 30 | 1.57 (1.19–2.07)[b] | 2.91 (1.16–7.28)[b] |
| Fried squid | 52 | 18 | 44 | 30 | 1.24 (0.98–1.57)[a] | 0.66 (0.40–1.10) |
| Fried mixed vegetables | 25 | 8 | 65 | 40 | 1.28 (1.03–1.59)[b] | 1.50 (0.73–3.08) |
| Chicken in sour soup | 73 | 33 | 23 | 15 | 1.13 (0.85–1.51) | - |
| Candied pumpkin | 37 | 12 | 55 | 36 | 1.27 (1.02–1.59)[b] | 1.30 (0.49–3.46) |
| **27 April, 10 AM–2 PM**[c] | | | | | | |
| Eclairs | 32 | 13 | 59 | 35 | 1.17 (0.94–1.47)[a] | 1.04 (0.63-1.70) |
| Fried mushroom with shrimp | 54 | 19 | 37 | 29 | 1.34 (1.05–1.72)[b] | 1.32 (0.51–3.41) |
| Fried snapper with celery | 47 | 15 | 45 | 33 | 1.33 (1.06–1.68)[b] | 1.02 (0.39–2.63) |
| Fried anise with shrimp | 24 | 6 | 66 | 42 | 1.36 (1.10–1.68)[b] | 2.08 (0.60–7.17) |
| Chicken in sour soup | 72 | 33 | 24 | 15 | 1.11 (0.84–1.47)[a] | 0.89 (0.57–1.39) |

*Note: CI: confidence interval. RR: relative risk. OR: odds ratio. [a]p-value <0.2 in univariate analysis. [b]p-value <0.05. [c]At the dinner on 27 April the participants did not eat together*

**Table 2. Risk factors in a gastroenteritis outbreak among the second seminar participants, Songkhla Province, 8–13 May 2019 (n=205)**

| Food items (date and time served) | Exposed | | Non-exposed | | Crude RR (95% CI) | Adjusted OR (95% CI) |
|---|---|---|---|---|---|---|
| | Case | Non-case | Case | Non-case | | |
| **Drinks during 8–9 May** | | | | | | |
| Water in a cooler | 106 | 41 | 32 | 23 | 1.23 (0.96–1.58)[a] | 1.98 (1.01–3.87)[b] |
| Juice | 55 | 22 | 83 | 41 | 1.06 (0.88–1.28) | - |
| **Food items by date and time** | | | | | | |
| **8 May, 10–13 AM (not all participants attended this period)** | | | | | | |
| Steamed dumpling | 53 | 29 | 14 | 8 | 1.01 (0.76–1.44) | - |
| Omelet | 130 | 56 | 11 | 8 | 1.21 (0.78–1.81) | - |
| Sour soup with fish | 43 | 27 | 25 | 10 | 0.86 (0.65–1.13) | - |
| **8 May, 6 PM (welcome dinner)** | | | | | | |
| Spicy seafood salad | 119 | 53 | 21 | 11 | 1.05 (0.80–1.38) | - |
| Roasted duck | 124 | 48 | 16 | 16 | 1.44 (1.01–2.06)[b] | 1.31 (0.83–2.06) |
| Fried squid | 105 | 42 | 35 | 22 | 1.16 (0.92–1.46)[a] | 0.96 (0.77–1.19) |
| Shrimp in sauce | 122 | 54 | 18 | 10 | 1.07 (0.80–1.44) | - |
| Fried mixed vegetables | 98 | 35 | 42 | 29 | 1.24 (1.00–1.54)[b] | 1.28 (0.90–1.83) |
| Thai dessert | 107 | 44 | 33 | 20 | 1.14 (0.90–1.45) | - |
| **9 May, 10 AM–1 PM** | | | | | | |
| Boiled egg | 89 | 43 | 46 | 20 | 0.96 (0.79–1.17) | - |
| Chicken in sour soup | 115 | 50 | 20 | 13 | 1.15 (0.85–1.54) | - |
| Fried lettuce | 104 | 40 | 31 | 23 | 1.25 (0.97–1.61)[a] | 0.67 (0.40–1.02) |
| Mixed fruit | 107 | 51 | 28 | 12 | 0.94 (0.76–1.21) | - |

*Note: CI: confidence interval. RR: relative risk. OR: odds ratio. [a]p-value <0.2 in univariate analysis. [b]p-value <0.05*

## Laboratory Results

A total of 21 fecal specimens from the cases were negative for bacterial pathogen. Five of nine (55.5%) rectal swabs from the cases on 13 May were positive for rotavirus and 2 (22.2%) samples were positive for norovirus. Rotavirus was also identified in fecal matter of 3 food handlers and 1 sample of water for cooking. The same genotype G9P[8] was confirmed among the cases and food handlers. Adenovirus was identified in fecal matter of a food handler and water for cooking and drinking. *Escherichia coli* and *Staphylococcus aureus* were also identified from samples of water for cooking and drinking (Table 3).

**Table 3. Gastrointestinal pathogen isolates from gastroenteritis cases, asymptomatic food handlers and water samples from the study hotel, Songkhla Province, 26 Apr–13 May 2019**

| Source of isolates | Collection date | Bacterial culture | | Viral RT-PCR | |
|---|---|---|---|---|---|
| | | Number of isolates (samples) | Pathogen (n) | Number of isolates (samples) | Pathogen (n) |
| **Symptomatic cases** | 28–29 April | 0 (5) | - | Not collected | - |
| | 7 May | Not collected | - | 0 (4) | - |
| | 13 May | 0 (16) | - | 7 (9) | Rotavirus, G9P[8] (3)<br>Rotavirus, untyped (2)<br>Norovirus (2) |
| **Asymptomatic food handlers** | 8 May | 1 (12) | *A. veronii* (1) | 2 (11) | Rotavirus, G9P[8] (2) |
| | 13 May | Not collected | - | 2 (16) | Rotavirus (1)<br>Adenovirus (1) |
| **Water for cooking**[a] | 29 April | 1 (1) | *E. coli* (1)<br>*S. aureus* (1) | Not collected | - |
| | 8 May | Not collected | - | 1 (1) | Rotavirus (1)<br>Adenovirus (1) |
| **Drinking water**[b] | 29 April | 1 (1) | *E. coli* (1)<br>*S. aureus* (1) | Not collected | - |
| | 8 May | Not collected | - | 1 (1) | Adenovirus (1) |

*Note: [a]water from the retention system. [b]water from the water cooler near the seminar room*

## Environmental Investigation

The source of water for the hotel is tap water and a groundwater well which is located near a sewage pond. The water for cooking and drinking come from both water sources because the pipe system is interconnected. Water from the well goes through a filter system without any chlorination or other disinfection process (Figure 3). No chlorine was detected from water obtained from the end of the pipe.

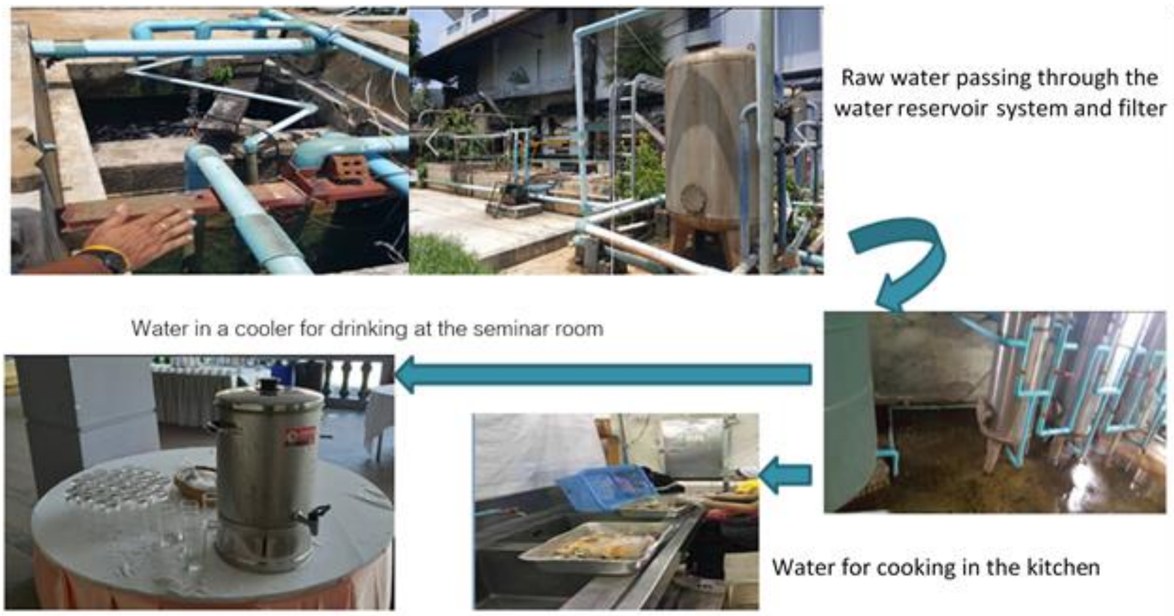


**Figure 3. Trace back of the water for cooking and water in a cooler, a gastroenteritis outbreak, Songkhla Province, 26 Apr–13 May 2019**

## Discussion

Rotavirus and norovirus were considered as the probable causative agents of these acute gastroenteritis outbreaks with rotavirus as the main pathogen for the 2nd seminar. Rotavirus outbreaks among adults is not confined to geriatric populations. Many studies among healthy adults showed that the prevalence of symptoms among infected cases ranges from 22–50%.[7,19–23] We did not test for viral pathogens among asymptomatic participants, so our attack rate may be lower than the actual infection rate. A gastroenteritis outbreak investigation among adolescents and adults presenting with watery diarrhea, fever, nausea, and abdominal cramping should consider viral causes, including rotavirus and norovirus, in the differential diagnosis. Our report showed a delay in laboratory investigation for viral pathogens in the first cluster according to the contribution of viral pathogens that typically affect children is not recognized. Although the pathogen could not be confirmed from cases of the first cluster, due to the clinical presentation and the linkage of infected food handlers and contamination of water source, the same rotavirus infection is suspected to have caused both outbreaks.

The rotavirus G9P[8] strain was found during the outbreak and was implicated as the main pathogen. The G9P[8] strain was reported as a cause of the largest outbreak of rotavirus disease in Central Australian history in May 2001 when a total of 246 children with acute gastroenteritis arrived at the emergency department of the Alice Springs Hospital, of which 137 were hospitalized.[5] The severity of the cases in that study was higher than in our study probably because our population at risk were healthy adolescents and adults. The rotavirus surveillance project in Thailand during July 2001–June 2003 showed that the G9 serotype is predominant each year, while other identified rotavirus serotypes included G2, G4, G1, and G3.[31]

A spicy seafood salad, roast duck with vegetables, shrimp in sauce and drinking water from a cooler were the most likely sources of infection supported by laboratory confirmation of rotavirus detected in stool samples of food handlers and water for cooking which came from the same source as the drinking water. Many food items may have been contaminated with the pathogen by cross-contamination from infected food handlers or from the water used as an ingredient or for cleaning raw materials such as vegetables that were then added to the dishes without heating. Previous water and foodborne rotavirus outbreaks such as a waterborne outbreak of gastroenteritis in 1981 in Eagle-Vail and Avon, Colorado, United States in which severity of symptoms correlated with the amount of tap water consumed and foodborne rotavirus outbreaks reported in Japan and the United States.[25–27]

Groundwater can provide safe drinking water as long as the source is not polluted and the water is sufficiently treated. Public water systems often use a series of water treatment steps that include coagulation, flocculation, sedimentation, filtration, and disinfection. At the disinfection stage, chlorine, chloramines, ozone or other disinfectants are added to the water to destroy potential pathogens such as bacteria, viruses, and parasites.[28,29] The drinking water and water used for cooking at the affected hotel came from a groundwater well which was located near a sewage pond. We found many gastrointestinal pathogens including rotavirus, adenovirus, *Escherichia coli*, and *Staphylococcus aureus* in stool samples obtained from the food handlers and in the water supply, suggesting that the water source was contaminated with human feces. The most likely cause of contamination was leakage from the nearby sewage pond and/or deterioration of the water pipe system. There was no disinfection process on the water used for drinking and cooking.

Asymptomatic infection among food handlers was suspected to play an important role in disease transmission. Pathogens can be introduced into food from infected humans who handle the food without thoroughly washing their hands.[30] According to the standard of food safety, a food business should exclude employees who have a foodborne disease from handling food until a medical practitioner confirms that the employee no longer has the disease. However, among asymptomatic infected food handlers, good personal hygiene is important to prevent food contamination. Ready-to-eat food should not be handled with bare hands and food handlers are recommended to practice proper hand-washing after handling raw meat, before and after wearing gloves, going to the toilet, handling waste, and after cleaning food.[31]

## Public Health Action and Recommendations

We recommend that hotel authorities improve the quality of their water for drinking and cooking as the first priority. Firstly, the hotel should provide bottled water from an external source for drinking and use only tap water that has passed the disinfection system for cooking by installing a new pipe. All food items and raw materials must be heat treated. The infected food handlers should be prevented from touching food until the test results show no infection. All surfaces and equipment in the kitchen should be disinfected with

1,000–5,000 ppm chlorine solution. The following steps should be included; new water pipes should be installed, tap water and well water should be separated, and an automatic chlorination system for well water should be added. Water for cooking and drinking should only come from tap water, and a new filter system should be installed by separating two sets of filters for cooking and drinking water.

After improving the hotel's water system, and providing health education to the food handlers to promote good personal hygiene, no further outbreaks were reported. To reduce the risk of developing large food-waterborne outbreaks in a hotel, it is important to show that materials, preparation process and food handling are safe and documentation should be kept. Food hygiene authorities should regularly visit hotels to inspect the food and water sanitation system and take random samples for laboratory analysis.[25]

## Study Limitations

The investigators could not collect information from all participants, especially those who attended the first seminar, thus the analytic results may not reflect the whole cohort. Recall bias may have occurred by nature of the retrospective study and the large number of meals and food items consumed. We did not test for viral pathogens among asymptomatic participants and some participants may have developed the disease after the investigation had concluded.

## Conclusion

An intermittent gastroenteritis outbreak at a Hotel in Songkhla Province during April to May 2019 was caused by mixed viral pathogens and rotavirus genotype G9P[8] was identified as the main pathogen. Cases were 237 participants of two seminars at the hotel and the attack rate was 67.9%. Contaminated water and infected food-handlers were important sources of cross- contamination. After the hotel's water system had been repaired and the food handlers were provided with health education to promote good personal hygiene, no further outbreaks were reported.

## Acknowledgements

The authors would like to express their gratitude to Songkhla Provincial Health Office, Songkhla Hospital, Hatyai Hospital, Tourist Assistance Unit, Ministry of Tourism and Sports, Regional Medical Science Center 12 Songkhla, Bamrasnaradura Infectious Diseases Institute, Neuroscience Centre for Research and Development and the Department of Disease Control for their support with this investigation.

## Suggested Citation

Sangsawang C, Chantutanon S, Sukhum L, Thepparat T. An intermittent gastroenteritis outbreak of rotavirus genotype G9P[8] in a hotel in Songkhla Province, Thailand, April–May 2019. OSIR. 2022 Jun;15(2):55–63.

## References

1. Kapikian AZ, Hoshino Y, Chanock RM. Rotaviruses, In: Knipe DM, Howley PM, Griffin DE, Lamb RA, Martin MA, Roizman B, Straus SE, Editors. Fields virology. 4th ed. Philadelphia: Lippincott Williams & Wilkins; 2001. p. 1787–834.
2. Tate JE, Burton AH, Boschi-Pinto C, Steele AD, Duque J, Parashar UD. 2008 estimate of worldwide rotavirus-associated mortality in children younger than 5 years before the introduction of universal rotavirus vaccination programmes: a systematic review and meta-analysis. Lancet Infect Dis. 2012;12(2):136–41.
3. Santos N, Hoshino Y. Global distribution of rotavirus serotypes/genotypes and its implication for the development and implementation of an effective rotavirus vaccine. Rev Med Virol. 2005 Jan–Feb;15(1):29–56.
4. Damanka SA, Agbemabiese CA, Dennis FE, Lartey BL, Adiku TK, Enweronu-Laryea CC, et al. Genetic analysis of Ghanaian G1P[8] and G9P[8] rotavirus A strains reveals the impact of P[8] VP4 gene polymorphism on P-genotyping. PLoS One [Internet]. 2019 Jun 26 [cited 2022 Apr 14];14(6):e0218790. <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0218790>
5. Kirkwood C, Bogdanovic-Sakran N, Barnes G, Bishop R. Rotavirus serotype G9P[8] and acute gastroenteritis outbreak in children, Northern Australia. Emerg Infect Dis. 2004 Sep;10(9):1593–600.
6. Anderson EJ, Weber SG. Rotavirus infection in adults. Lancet Infect Dis. 2004 Feb;4(2):91–9.
7. Bonsdorff CH, Hovi T, Makela P, Morttinen A. Rotavirus infections in adults in association with acute gastroenteritis. J Med Virol. 1978;2(1):21–8.
8. Foster SO, Palmer EL, Gary GW Jr, Martin ML, Herrmann KL, Beasley P, et al. Gastroenteritis due to rotavirus in an isolated Pacific island group: an epidemic of 3,439 cases. J Infect Dis. 1980 Jan;141(1):32–9.

9. Marrie TJ, Lee SH, Faulkner RS, Ethier J, Young CH. Rotavirus infection in a geriatric population. Arch Intern Med. 1982 Feb;142(2):313–6.

10. Cubitt WD, Holzel H. An outbreak of rotavirus infection in a long-stay ward of a geriatric hospital. J Clin Pathol. 1980 Mar;33(3):306–8.

11. Dupuis P, Beby A, Bourgoin A, Lussier-Bonneau MD, Agius G. Epidemic of viral gastroenteritis in an elderly community. Presse Med. 1995 Feb;24(7):356–8.

12. Abbas AM, Denton MD. An outbreak of rotavirus infection in a geriatric hospital. J Hosp Infect. 1987 Jan;9(1):76–80.

13. Lewis DC, Lightfoot NF, Cubitt WD, Wilson SA. Outbreaks of astrovirus type 1 and rotavirus gastroenteritis in a geriatric inpatient population. J Hosp Infect. 1989 Jul;14(1):9–14.

14. Division of Viral Disease, National Center for Immunization and Respiratory Diseases. Rotavirus [Internet]. Atlanta: Center for Disease Prevention and Control; 2021 Mar 26 [cited 2022 Apr 25]. <https://www.cdc.gov/rotavirus/clinical.html#>

15. Stuempfig ND, Seroy J. Viral gastroenteritis [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 [cited 2022 Apr 28]. <https://www.statpearls.com/ArticleLibrary/viewarticle/22095>

16. El Sayed Zaki M, Abo El Kheir N. Molecular study of astrovirus, adenovirus and norovirus in community acquired diarrhea in children: One Egyptian center study. Asian Pac J Trop Biomed. 2017 Nov;7(11):987–90.

17. Filho EP, da Costa Faria NR, Fialho AM, de Assis RS, Almeida MM, Rocha M, et al. Adenoviruses associated with acute gastroenteritis in hospitalized and community children up to 5 years old in Rio de Janeiro and Salvador, Brazil. J Med Microbiol. 2007 Mar;56(Pt 3):313–9.

18. Bosch A, Pinto RM, Guix S. Human astroviruses. Clin Microbiol Rev. 2014 Oct;27(4):1048–74.

19. Kapikian AZ, Wyatt RG, Levine MM, Yolken RH, Vankirk DH, Dolin R, et al. Oral administration of human rotavirus to volunteers: induction of illness and correlates of resistance. J Infect Dis. 1983 Jan;147(1):95–106.

20. Ward RL, Bernstein DI, Shukla R, Young EC, Sherwood JR, NcNeal MM, et al. Effects of antibody to rotavirus on protection of adults challenged with a human rotavirus. J Infect Dis. 1989 Jan;159(1):79–88.

21. Ward RL, Bernstein DI, Shukla R McNeal MM, Sherwood JR, Young EC, et al. Protection of adults rechallenged with a human rotavirus. J Infect Dis. 1990 Mar;161(3):440–5.

22. Ward RL, Bernstein DI, Young EC, Sherwood JR, Knowlton DR, Schiff GM. Human rotavirus studies in volunteers: determination of infectious dose and serological response to infection. J Infect Dis. 1986 Nov;154(5):871–80.

23. Middleton PJ, Abbott GD, Szymanski MT, Bortolussi R, Hamilton JR. Orbivirus acute gastroenteritis of infancy. Lancet. 1974 Jun;303(7869):1241–4.

24. Jiraphongsa C, Bresee JS, Pongsuwanna Y, Kluabwang P, Poonawagul U, Arporntip P, et al. Epidemiology and burden of rotavirus diarrhea in Thailand: results of sentinel surveillance. J Infect Dis. 2005 Sep 1;192 Suppl 1:S87–93.

25. Hopkins RS, Gaspard GB, Williams FP Jr, Karlin RJ, Cukor G, Blacklow NR. A community waterborne gastroenteritis outbreak: evidence for rotavirus as the agent. Am J Public Health. 1984 Mar;74(3):263–5.

26. Japan Ministry of Health and Welfare, National Institute of Infectious Diseases. An outbreak of group A rotavirus infection among adults from eating meals prepared at a restaurant, April 2000–Shimane. IASR. 2000;21:145.

27. Centers for Disease Prevention and Prevention. Foodborne Outbreak of group A rotavirus gastroenteritis among college students, District of Columbia, March–April 2000. MMWR [Internet]. 2000 Dec 22 [cited 2022 Apr 18];49(50):1131–3. <https://www.cdc.gov/mmwr/preview/mmwrhtml/mm4950a2.htm>

28. Safe Drinking Water Foundation. Groundwater [Internet]. Saskatoon (CA): Safe Drinking Water Foundation; 2021 [cited 2022 Apr 28]. <https://www.safewater.org/fact-sheets-1/2017/1/23/groundwater>

29. Center for Disease Prevention and Control. Water treatment [Internet]. Atlanta: Centers for Disease Prevention and Control; 2022 [cited 2022 Apr 28]. <https://www.cdc.gov/healthywater/drinking/public/water_treatment.html>

30. Minnesota Department of Health. Food contamination and foodborne Illness prevention [Internet]. Minnesota:Minnesota Department of Health; 2022 [cited 2022 Apr 28]. <https://www.health.state.mn.us/people/foodsafety/prevention.html2022>

31. Rentokil PCI. Food safety for hotels and restaurants [Internet]. West Sussex (GB): Rentokil initial plc; [cited 2022 Apr 28]. <https://www.rentokil-pestcontrolindia.com/hospitality/food-safety-for-the-hospitality-sector/>